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July 8, 1959

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Dear Sir:

This letter report describes the research performed under Task Order No. C during the month of June, 1959.

During this period, two runs, namely, 14-B and 15, were made. Runs 14 and 14-A, reported last month, had shown that increasing the borohydride concentration by a factor of 2.24 over what has been considered standard concentration caused an unexpected decrease in the total generation time. The purpose of the current runs was to determine the effect of solution depth on the total generation time.

Run 14-B, a small-scale run, was designed using Run 14-A as the control. Run 15 was a 1/5-scale test planned with Run 14 as the control. The equivalent concentrations of the reactants in these runs was the same.

The data for Runs 14-B and 15, along with the respective controls, Runs 14-A and 14, are summarized on the following page.

In Run 14-B, the solution depth of 8 inches was twice that for Run 14-A. The reaction was carried out in the open-top glass reactor vessel used for Run 14-A. The progress of the reaction was followed by automatically recording the temperature rise and by visual observation. The catalyst solution in Run 14-B was distributed over the top of the borohydride solution with the aid of

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	Run No.			
	14-A	14-B	14	15
Weight of NaBH_4	272.6 g	538.5 g	10.0 lb	20.0 lb
Weight of catalyst ($\text{CoCl}_2 \cdot 6\text{H}_2\text{O}$)	85.6 g	169.0 g	3.13 lb	6.26 lb
Volume of river water plus melted ice	5,705* ml	11,265* ml	25 gal	50 gal
Initial temperature, F	33	31	33	34
Temperature rise, F	98	102	114	112
Complete reaction time, min	15	24	10	32
Solution depth, inches	4	8	4	8

*Tap water plus melted ice.

a perforated Tygon ring. The black CO_2B precipitate, formed in the initial reaction, reached the bottom of the reaction vessel in 55 seconds. It appeared visually that mixing of the precipitate and of the solution was complete in approximately 3.5 minutes. The reaction in Run 14-B was violent at first and then slowed down for a period. Subsequently, the rate of gas evolution increased sufficiently to cause some of the solution to overflow the vessel.

Run 15 was similar to Run 14 (concentration-wise), but involved a solution depth of 8 inches rather than the 4-inch depth in Run 14. Since Run 15 was 1/5-scale with respect to the NaBH_4 concentration, a larger gas outlet tube was provided; also, the gas meter was by-passed as a safety measure, and the reaction was followed

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by observing the small-scale generation unit and automatically recording the solution temperature. Run 15 started in the usual manner. The generator did not show any evidence of a large quantity of hydrogen being generated upon addition of the catalyst, and generation proceeded normally for approximately 28 minutes. At this point, hydrogen evolution increased markedly and caused the generator unit to swell considerably. The turbulence and pressure caused the solution to spout through a small opening in the brass cap to which the outlet tube was attached. This so-called "surge" lasted during the 28 to 31-minute interval. The increase in the gas-evolution rate as the temperature of the pool increased is characteristic of all runs, but was more pronounced in Run 15 than in any of the previous runs. Run 15 was complete in 32 minutes.

The results of Runs 14-A and -B and 14 and 15 yield the following conclusions. At this increased borohydride concentration:

- (1) Mixing of the catalyst throughout the solution is more rapid and efficient.
- (2) Generation rates are increased markedly.
- (3) The effect of scaling is less apparent.
- (4) The last 30 to 40 per cent of gas is evolved rapidly.

Future work will include two 1/5-scale tests and a full-scale test. One 1/5-scale test will be conducted in our laboratory at an initial temperature of 42-43 F. This will involve a total solution of 50 gallons, and the amount of catalyst calculated to provide a total generation time of less than 1 hour. The other 1/5-scale test will

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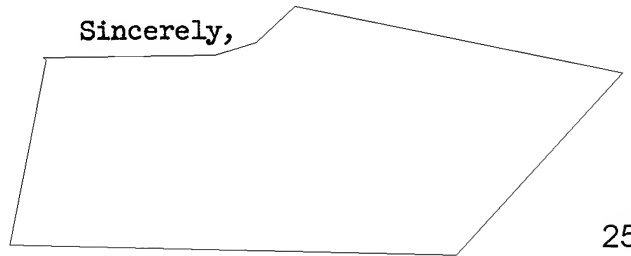
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be carried out subsequently at the site chosen for the full-scale test, at an initial temperature of 33 to 35 F. Also, consideration will be given to providing the small-scale generator unit with a manually operated stirrer, so that the solution can be agitated, if is deemed desirable.

The total appropriation under this Task Order was \$62,579. As of July 1, 1959, the unexpended balance was approximately \$3,800.

Sincerely,



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In Duplicate

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